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UNITED STATES DEPARTMENT OF AGRICULTURE
BULLETIN No. 402
Contribution from the Bureau of Plant Industry
WM. A. TAYLOR, Chief
Washington, D. C. October 3, 1916

CEREAL EXPERIMENTS AT THE AKRON FIELD STATION AKRON, COLO.

By
GEORGE A. McMURDO
Assistant, Office of Cereal Investigations

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INTRODUCTION.

The experiments with cereals at the Akron Field Station [1] were begun in the fall of 1907. They have been conducted for the following purposes: (1) To determine the best crops, crop varieties, and strains for that section of Colorado; (2) to improve varieties by breeding; and (3) to determine the best methods of cereal production.

This bulletin contains the results of experiments conducted during eight years, 1908 to 1915, inclusive. A period of eight years should be sufficient to warrant drawing some fairly accurate conclusions. It is believed, however, that the production factors in this period have been rather more favorable than can be expected in a longer period.

The data herein presented should indicate the relative values of the cereals. They should also show the best varieties of each cereal for this district and for localities with similar conditions.

[1] The Akron Field Station, Akron, Colo., is operated by the Office of Dry-Land Agriculture Investigations. The cereal experiments are conducted by the Office of Cereal Investigations in cooperation with the office named. These experiments were begun in 1907. Mr. Wilson G. Shelley was in charge from March 1, 1908, until Feb. 28, 1911. Mr. Clyde McKee was then appointed scientific assistant and placed in charge of cereal investigations at Akron, which position he retained till Feb. 15, 1913. He was then succeeded by Mr. Charles H. Clark, who remained till July 1, 1913, on which date he was transferred to take charge of flax investigations in the Office of Cereal Investigations. The writer of this bulletin was placed in charge of the cereal experiments at Akron on the date of Mr. Clark's transfer.

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DESCRIPTION OF THE DISTRICT.

The district here described includes northeastern Colorado and small adjacent portions of southeastern Wyoming, southwestern Nebraska, and northwestern Kansas. The results presented are believed to be generally applicable to similar soils in this district. The river valleys and sand hills present very different conditions.

HISTORY.

The district described formed part of the Great American Desert in the early history of the trans-Missouri West. It was the feeding ground for the bison and antelope. The bisons were exterminated by hunters and only a few antelopes remain. The bisons were succeeded by large herds of cattle. Vast areas were controlled by the few cattlemen who held the scattered water holes or owned the adjoining river land.

With the building of the railroads up the valleys of the Platte and the Republican Rivers and of other lines to the south came the first real farm settlement. The free Government lands brought thousands of settlers who did not understand dry-land conditions. Many did not remain long enough to obtain patents to their homesteads. Many of those who did remain borrowed money on the land, and later the mortgages were foreclosed. The result was that a wide strip of land on each side of the railroads soon came to be controlled by nonresident owners. This condition is gradually being changed, but the land far from the railroad is often the most thickly settled, even at the present time.

Farm experience and scientific experiments have built up a system of agriculture which promises to make possible the profitable reoccupation of lands held by nonresidents.

TOPOGRAPHY.

The district is a rolling prairie, bounded on the west by the foothills of the Rocky Mountains and on the east by an imaginary line located somewhere near the one hundredth meridian of longitude. It extends south to the high divide between the Arkansas and Republican Rivers and north to the divide between the Platte and Missouri Rivers. The Platte is the only important river traversing the district, and during the summer months its waters are often reduced to the proportions of a creek. The altitude varies from 3,500 to 5,500 feet. The topography of the section is shown in figure 1.

The water supply is almost entirely from wells. The depth varies from a few feet to several hundred feet. In some localities water has not been located at any depth. New settlers should make sure that a supply of good water is available.

SOIL.

Geologically the district was once part of the bed of a Cretaceous sea. It contains many deposits of marine fossils which add to the natural fertility. The rolling character of the surface is partly due to wind action. Movements due to wind are still in progress, but vegetation retards the action. Many depressions formed by wind have no drainage outlet. The result of the combined forces is a sandy soil, often of considerable depth, very deficient in humus. In a few localities the subsoil is very different from the topsoil. Clay may be found only 1 or 2 feet below the sand. The natural vegetation is an indicator to the experienced eye of the character of the soil;[1] but no examination of land in this district is complete until a few holes have been dug to a depth of 4 or 5 feet. The very sandy lands should not be broken, on account of soil blowing.

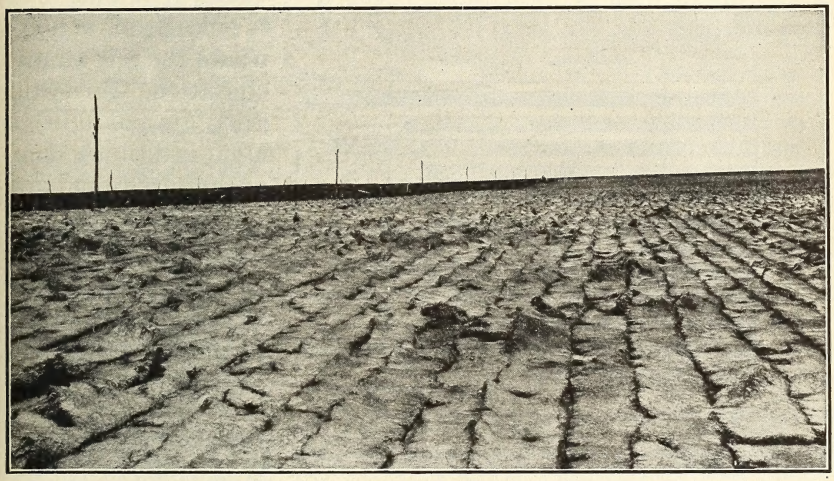

FIG. 1.—Sod broken with a moldboard plow near the Akron Field Station, showing the topography of the locality.

An estimate based on the figures of the Thirteenth Census places the proportion of cultivated land at about 6 per cent of the total area and the proportion in cereals at about 2.5 per cent of the total area.

CLIMATE.

The climate of the district is healthful. The air is dry and is usually in motion. Strong winds are very common, but tornadoes are rare. The winters are generally mild and open, but occasionally snow falls early and remains until spring.

There is a gradual decrease in precipitation from east to west. About two-thirds of the precipitation falls during the growing season,

[1] Shantz, H. L. Natural vegetation as an indicator of the capabilities of land for crop production in the Great Plains area. U. S. Dept. Agr., Bur. Plant Indus. Bul. 201, 100 p., 23 fig., 6 pl. 1911.

March to July, inclusive. A more detailed discussion of climatic data recorded at the Akron Field Station follows.

PRECIPITATION.

In general, the precipitation of eastern Colorado decreases as the altitude increases, or from east to west. When the foothills are reached, however, there is a rapid increase in rainfall. The rainfall is also greater on the high divide between the Platte and Arkansas Rivers than at lower elevations to the north or south. In the river valleys the additional precipitation from local showers may considerably affect the total. Local storms of greater or less importance occur every year. They are most common during the summer months. At other times the storm area is usually quite extensive. The limits of the local storms are often very clearly marked. A rainfall of an inch or more may occur at a distance of only 2 or 3 miles from a point where there is no precipitation. Torrential rains are not uncommon, and much damage results from hail.

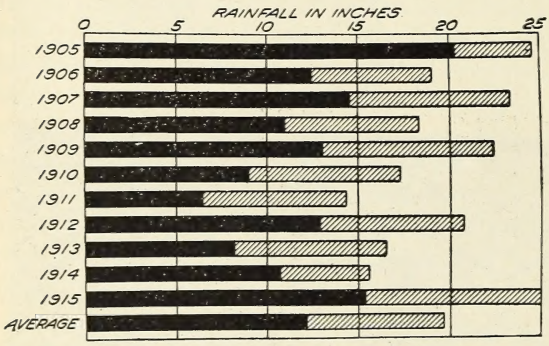

FIG. 2.—Diagram showing the seasonal and annual precipitation at the Akron Field Station for eleven years, 1905 to 1915, inclusive. The solid bars show the seasonal precipitation, while the total length of the bars shows the annual precipitation.

The distribution of precipitation throughout the year is usually favorable to cereal production. The annual and seasonal rainfall at Akron from 1905 to 1915 is shown graphically in figure 2. The annual and average precipitation by months for the 11 years from 1905 to 1915 is given in Table I. The data for the first three years and portions of the fourth and fifth years, as noted, are from the records of the United States Weather Bureau. These observations were made at the town of Akron, which is about 90 feet higher in elevation than the field station and about 4 miles distant. The remaining data are from the records of the Biophysical Laboratory of the Bureau of Plant Industry at the Akron Field Station.

The average precipitation in the 11-year period, 1905 to 1915, inclusive, as shown in Table I, is 19.72 inches. Of this total, 12.33 inches fell during the months from March to July, inclusive, or during the period which most affects the production of the cereals.

TABLE I.—*Monthly, seasonal, and annual precipitation at and near Akron, Colo., during the 11-year period, 1905 to 1915, inclusive.*

[Data (in inches) from the records of the Biophysical Laboratory of the Bureau of Plant Industry, except the following from the records of the United States Weather Bureau at Akron, Colo.: (1) For the years 1905, 1906, and 1907; (2) for January to May, inclusive, and October to December, inclusive, in 1908; (3) for January to March, inclusive, and October to December, inclusive, in 1909. T=trace.]

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.	Seasonal.[1]	
														Mar. to July.	Aug. to Oct.[2]
1905	0.37	0.32	5.45	4.55	4.37	2.14	3.82	0.86	0.83	1.73	0.12	0	24.56	20.33	3.42
1906	.25	.26	1.51	4.22	3.32	1.20	2.46	1.26	1.00	1.90	1.56	.08	19.02	12.71	4.16
1907	0	T.	.43	1.74	3.30	3.26	6.06	5.13	1.86	.02	1.00	.60	23.40	14.79	7.01
1908	0	.34	T.	1.70	3.57	2.35	3.40	1.62	.22	3.20	2.00	T.	18.38	11.02	5.04
1909	T.	1.38	3.06	.40	1.87	3.32	4.61	3.77	2.16	.78	.48	.55	22.38	13.26	6.71
1910	.05	.16	.26	3.96	2.06	1.38	1.47	3.72	3.81	.05	.12	.32	17.36	9.13	7.58
1911	.60	.44	.06	2.63	1.15	1.48	1.34	1.30	2.40	1.47	.28	1.36	14.51	6.66	5.17
1912	.28	1.43	.78	2.49	2.86	3.39	3.58	1.58	1.88	1.99	.18	.29	20.73	13.10	5.45
1913	.22	.40	1.57	2.19	1.44	1.35	1.85	1.14	2.08	.34	.30	3.67	16.55	8.40	3.56
1914	.03	.32	.20	4.01	1.46	3.54	1.66	1.05	.23	2.08	.10	.90	15.58	10.87	3.36
1915	1.10	1.68	1.50	5.19	4.13	3.75	1.10	3.51	1.76	.48	.15	.65	25.00	15.67	5.75
Average	.27	.61	1.34	3.00	2.68	2.46	2.85	2.26	1.65	1.27	.57	.76	19.72	12.33	5.20

[1] Months inclusive. [2] Rainfall affecting the fall growth of winter grains.

TABLE II.—*Monthly and annual precipitation recorded near Leroy, Colo., during the 25-year period, 1891 to 1915, inclusive.*

[Data (in inches) from the records of the United States Weather Bureau at Leroy, Colo. T=trace.]

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
1891	1.70	1.00	1.99	1.35	5.02	4.84	4.69	2.89	0.67	0.14	0.37	0.95	25.61
1892	.89	2.24	.80	4.02	2.53	1.48	3.07	0	.84	1.66	.10	.65	18.28
1893	.05	1.20	.87	.46	2.73	0	1.75	.61	.41	.41	.48	.94	9.91
1894	.35	.46	.95	.98	.17	.75	1.16	.47	1.06	.08	.26	.65	7.34
1895	.73	.88	.40	2.43	2.05	2.94	2.56	.79	.42	.11	.47	.12	13.90
1896	.53	.24	1.20	1.91	2.36	3.77	1.33	.87	.86	.90	.20	.01	14.18
1897	.60	.72	1.66	1.77	3.08	2.24	1.39	2.79	.41	2.61	.40	.81	18.48
1898	.38	.26	.67	1.04	4.60	1.31	2.83	1.13	1.27	.54	.65	.27	14.95
1899	.50	.33	1.21	1.57	2.93	.28	2.17	2.36	.88	.30	.23	.44	13.20
1900	.10	.96	.12	7.27	2.10	.78	1.68	.99	.35	.07	.12	.20	14.74
1901	.06	.49	1.60	2.92	.72	2.52	.97	4.03	.27	.47	T.	.89	14.94
1902	.12	.72	1.23	1.26	3.16	1.82	.98	3.70	3.46	.78	.09	.99	18.33
1903	.18	1.50	.26	1.12	.80	1.07	1.71	3.44	.62	.29	.06	.03	11.08
1904	.10	.26	.35	1.99	3.97	4.39	3.46	1.77	2.96	1.55	.04	.05	20.29
1905	.17	.30	3.28	4.70	3.88	2.48	2.56	1.96	.78	1.93	.12	.02	22.18
1906	.23	.43	1.38	4.53	1.96	1.35	1.88	2.83	2.70	2.69	1.29	.53	21.80
1907	.12	.05	.25	.97	2.85	2.67	2.24	4.19	1.88	T.	.66	.69	16.57
1908	.08	.23	.18	1.68	4.34	3.52	5.72	3.65	.16	3.76	1.86	.05	25.23
1909	.01	1.30	1.80	1.01	1.67	4.15	1.05	2.14	2.81	.56	.91	1.08	18.49
1910	.04	.04	.62	1.96	2.34	2.06	1.53	1.95	1.72	.13	.13	.36	12.88
1911	.32	.24	.10	3.13	1.74	2.21	2.50	1.68	1.16	1.87	.18	.92	16.05
1912	.26	1.16	1.65	2.62	2.58	3.32	1.81	1.60	2.31	2.52	.42	.16	20.41
1913	.21	.96	.77	2.01	2.54	.52	2.96	1.62	1.08	1.17	T.	3.54	17.38
1914	.03	.35	.09	3.45	.78	3.17	2.85	3.54	.04	1.71	.02	.58	16.61
1915	.85	.63	2.09	4.66	4.98	4.45	1.07	5.13	1.63	.62	.24	.76	27.11
Average	.34	.68	1.02	2.43	2.63	2.32	2.23	2.24	1.23	1.07	.37	.63	17.19

The annual precipitation varied from 14.51 inches in 1911 to 25 inches in 1915. The seasonal precipitation varied from 6.66 inches in 1911 to 20.33 inches in 1905. Within the period for which crop records are presented the maximum seasonal precipitation was 15.67

inches in 1915. The seasonal precipitation has been closely correlated with the yield in bushels per acre. The average precipitation, as computed from records of the 11 years, will probably be reduced when the records from a longer series are available. This is evident from the fact that at Leroy, Colo., the 25-year normal precipitation is 17.19 inches (Table II). Leroy is located about 30 miles northeast of the Akron Field Station and is subject to similar climatic influences. The average precipitation during the 11-year period, 1905 to 1915, is 19.51 inches at Leroy and 19.72 inches at the Akron Field Station.

A droughty condition often prevails from about June 15 to August 31. The precipitation which falls during this period usually comes in the form of light showers. As the temperatures are high during the summer months, this precipitation is rapidly lost by evaporation. Table III, which gives the daily precipitation record at the Akron Field Station for 1914, illustrates this point. This table shows that from June 15 to October 8 there were only two rains of more than 0.25 inch.

TABLE III.—*Daily precipitation recorded at the Akron Field Station, Akron, Colo., for the year 1914.*

[Data (in inches) from the records of the Biophysical Laboratory of the Bureau of Plant Industry. T=trace.]

1914	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1					0.25	0.81						
2				0.20			0.02					
3								T.		0.17		
4			T.			.04	T.	T.		T.		
5		0.02		T.	T.							
6				.12			.03		0.07	T.		0.10
7				T.		T.			T.	T.		.40
8									.08	.26		.10
9	0.03		T.	.16					.02	.14		.10
10								T.				
11					.10	.07						
12						.11	T.					
13					.90	.26		0.01	.06			
14						2.24	T.					
15					.13	T.						
16				.46	.03		T.		T.		0.10	
17				.27	T.		.47	.10				
18			T.	T.	T.		.23	.25				
19			T.				T.	.03				
20						.01		.04	T.			
21							T.			.06		.20
22		.30		.02	T.		T.			.49		
23				.87				.02		.96		
24			T.	T.		T.		.14				
25							T.	.22				
26				.35			.17	.22				
27				T.	.05		.01					
28			0.20	T.	T.		.08					
29			T.	.49			T.					
30			T.	1.07		T.	.65	.02				
31					T.			T.				
Total	.03	.32	.20	4.01	1.46	3.54	1.66	1.05	.23	2.08	.10	.90

EVAPORATION.

As a factor affecting crop production the seasonal evaporation probably ranks next in importance to precipitation at the Akron Field Station. The total evaporation from a free water surface for each

month from April to September, inclusive, in the 8-year period, 1908 to 1915, is given in Table IV. The precipitation for the same period is included, and the ratio of precipitation to evaporation each year is also given. The data show that evaporation from the free water surface increases when precipitation decreases, but not in exact ratio. The highest evaporation was recorded in 1911, but the lowest precipitation occurred in 1913. The year of lowest evaporation was 1915, which was also the year of highest precipitation. The ratio of precipitation to evaporation over the total period for which records are available is 1 to 2.9.

TABLE IV.—*Monthly precipitation and evaporation from a free water surface at the Akron Field Station, Akron, Colo., from April to September of each year, 1908 to 1915, inclusive.*

[Data (in inches) from the records of the Biophysical Laboratory of the Bureau of Plant Industry.]

Year.	April.		May.		June.		July.		August.		September.		Total.		Ratio.
	Precipitation.	Evaporation.	Precipitation.	Evaporation.	Precipitation.	Evaporation.	Precipitation.	Evaporation.	Precipitation.	Evaporation.	Precipitation.	Evaporation.	Precipitation.	Evaporation.	
1908	1.70	4.740	3.57	7.709	2.35	8.637	3.40	8.474	1.62	7.826	0.22	8.550	12.86	45.936	1:3.5
1909	.40	4.734	1.87	6.825	3.32	7.003	4.61	9.396	3.77	8.538	2.16	5.857	16.13	42.353	1:2.6
1910	3.96	6.387	2.06	5.797	1.38	8.722	1.47	9.763	3.72	7.142	3.81	5.810	16.40	43.621	1:2.6
1911	2.63	5.841	1.15	7.323	1.48	9.753	1.34	9.774	1.30	8.944	2.40	7.183	10.30	48.818	1:4.8
1912	2.49	4.576	2.86	7.097	3.39	6.750	3.58	7.618	1.58	7.048	1.88	4.648	15.78	37.737	1:2.3
1913	2.19	4.336	1.44	5.835	1.35	8.178	1.85	9.259	1.14	9.302	2.08	6.040	10.05	42.950	1:4.2
1914	4.01	4.290	1.46	5.608	3.54	7.509	1.66	8.654	1.05	8.364	.23	7.438	11.95	41.863	1:3.5
1915	5.19	4.220	4.13	5.033	3.75	5.883	1.10	6.660	3.5	5.820	1.76	5.793	19.44	33.409	1:1.7
Average	2.82	4.890	2.32	6.403	2.57	7.804	2.37	8.699	2.21	7.873	1.82	6.415	14.11	42.084	1:2.9

The precipitation and evaporation in the months of August and September are less important in the production of spring-sown cereals than in the production of those sown in the fall. The germination of winter wheat is often slow and sometimes very poor, due to the scarcity of moisture in the seed bed at the time of sowing. Crop growth and surface evaporation may have exhausted the moisture from the surface below the seeding depth, even though the lower levels contain sufficient moisture to maintain plant growth.

Very low humidity of the atmosphere, rapid transpiration from growing plants, and high wind velocity are responsible for the rapid and often premature ripening of cereals. For this reason the early-maturing varieties in each group usually produce a higher quality of grain than the later ones. The growth of all is checked at about the same time.

WIND.

Wind is an important element of the climatic influences in this section of the Great Plains. Records of wind velocity have been made during the summer months since 1908 and during the entire year since 1912. The available records for the 8-year period, 1908 to 1915, inclusive, as given in Table V, show an average wind velocity of 6.9 miles per hour. The months of April and May have average wind velocities higher than any of the other months. The highest wind velocity for any one month is 10.3 miles per hour, in May, 1909. The lowest wind velocity was recorded in August, 1915. The prevailing winds at the Akron Field Station are from the southwest during the summer and from the northwest during the winter.

TABLE V.—*Average wind velocity at the Akron Field Station, Akron, Colo., by months, 1908 to 1915, inclusive, as far as data are available.*

[Data (in miles per hour) from the records of the Biophysical Laboratory of the Bureau of Plant Industry.]

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Average.
1908	.....	.....	.....	.....	.....	8.0	6.0	6.7	7.6	.....	.....	.....	.....
1909	.....	.....	.....	9.0	10.3	6.8	6.8	5.8	6.7	.....	.....	.....	.....
1910	.....	.....	.....	.....	8.1	8.6	6.1	5.0	6.0	7.1	5.1	6.3	.....
1911	6.2	6.5	8.7	9.1	9.7	7.4	7.1	8.1	7.0	.....	.....	.....	.....
1912	6.7	7.5	7.8	9.9	8.5	6.1	5.4	4.7	6.0	6.1	5.7	6.3	6.7
1913	6.2	4.9	6.6	8.1	6.9	8.1	6.1	5.6	6.4	7.1	5.1	8.5	6.6
1914	8.2	6.6	8.5	8.7	7.4	5.8	5.8	6.5	6.9	6.4	6.2	5.8	6.9
1915	8.0	6.5	7.3	7.5	7.7	6.8	6.2	4.3	6.4	5.7	7.9	6.0	6.7
Average	7.0	6.4	7.7	8.7	8.3	7.2	6.2	5.8	6.6	6.9	6.0	6.6	6.7

TEMPERATURE.

The temperatures at the Akron Field Station are recorded by means of maximum and minimum dry-bulb thermometers, supplemented by a thermograph during the growing season. A summary of the recorded data is given in Table VI. The records are complete for the six months from April to September, inclusive, for the 8-year period, 1908 to 1915. Sufficient data are available for other months during a portion of this period to form a good basis for study.

The month of August has the highest average maximum temperature, 85° F. December and January have the lowest average minimum, 13° F. The highest maximum for any one month is 90° F., recorded for July, 1910. Temperatures of 100° F. are not uncommon during July and August. The combination of high winds and high temperatures with only light showers usually causes a droughty condition to prevail from about June 15 to August 31, as noted in the discussion of precipitation.

TABLE VI.—*Mean, maximum, and minimum temperatures at the Akron Field Station, Akron, Colo., by months, 1908 to 1915, inclusive, so far as data are available.*

[Data (in ° F.) from the records of the Biophysical Laboratory of the Bureau of Plant Industry.]

Year.	January.			February.			March.			April.			May.			June.		
	Mean.	Maximum.	Minimum.	Mean.	Maximum.	Minimum.	Mean.	Maximum.	Minimum.	Mean.	Maximum.	Minimum.	Mean.	Maximum.	Minimum.	Mean.	Maximum.	Minimum.
1908	....	....	....	....	....	....	....	....	....	51	70	32	55	71	40	64	79	49
1909	....	....	....	....	....	....	....	....	....	42	55	29	52	68	39	64	79	52
1910	....	....	....	....	....	....	....	....	....	50	65	35	53	66	40	67	82	51
1911	33	48	17	28	42	14	43	60	26	47	62	31	58	73	43	70	87	53
1912	20	32	8	26	36	16	20	29	11	45	58	32	55	70	42	63	75	49
1913	24	37	10	18	29	7	34	47	21	47	63	33	57	72	44	67	82	53
1914	31	42	21	25	39	12	37	52	23	45	58	34	57	70	44	68	83	50
1915	22	33	11	32	42	22	29	39	19	50	62	38	52	64	41	60	72	49
Average	26	38	13	25	37	14	32	45	20	47	61	33	55	69	41	65	79	50

Year.	July.			August.			September.			October.			November.			December.		
	Mean.	Maximum.	Minimum.	Mean.	Maximum.	Minimum.	Mean.	Maximum.	Minimum.	Mean.	Maximum.	Minimum.	Mean.	Maximum.	Minimum.	Mean.	Maximum.	Minimum.
1908	70	84	55	69	84	54	66	84	48	....	....	....	....	....	....	....	....	....
1909	71	86	59	72	88	59	60	76	47	....	....	....	....	....	....	....	....	....
1910	74	90	59	67	84	54	63	79	49	52	71	35	40	56	24	31	47	17
1911	70	86	55	69	86	54	64	80	50	....	....	....	....	....	....	....	....	....
1912	70	84	55	69	83	55	54	68	41	47	63	34	40	55	25	29	....	14
1913	72	88	55	75	91	59	58	70	45	45	59	31	42	56	28	21	30	13
1914	72	87	58	71	88	55	64	83	47	50	67	36	41	60	25	17	29	7
1915	67	81	54	64	79	52	60	76	47	51	69	36	38	55	24	28	40	15
Average	71	73	56	69	85	55	61	77	46	49	65	34	40	56	25	25	36	13

Table VII gives the dates of the last spring and the first fall frosts and the number of days in the frost-free period of each year from 1909 to 1915, inclusive. The latest date on which frost has occurred in the spring during the seven years was May 20, and the average date is May 13. The earliest frost in the fall was September 13, and the average date is September 26. A temperature low enough to cause some injury occurred on August 25, 1910.

TABLE VII.—*Annual and average dates of killing frosts,*[1] *the last in spring and the first in autumn, with the annual and average length of the frost-free period, at the Akron Field Station, Akron, Colo., 1909 to 1915, inclusive.*

[Data from the records of the Biophysical Laboratory of the Bureau of Plant Industry.]

Item.	1909	1910	1911	1912	1913	1914	1915	Average.
Frost:								
Last in spring	May 14	May 21	May 10	May 14	May 4	May 12	May 20	May 13
First in fall	[2]Oct. 9	Sept. 25	Oct. 3	Sept. 20	Sept. 24	Sept. 13	Oct. 4	Sept. 26
Frost-free period, days	148	127	146	129	143	124	137	136

[1] A temperature of 32° F. is considered frost in the spring when vegetation is tender and a temperature below 32° F. is considered frost in the fall.

[2] Record from Leroy, Colo.

THE AKRON FIELD STATION.

The following paragraphs contain a description of the Akron Field Station, the scope of the experiments, and the methods employed in conducting them.

LOCATION.

The Akron Field Station is located 4 miles east of Akron, the county seat of Washington County, in northeastern Colorado. It is about 60 miles south of the Nebraska line and 60 miles west and 11 miles north of the point where Colorado meets the north line of Kansas. The Chicago, Burlington, & Quincy Railroad bounds the station on the south. Denver lies about 115 miles southwest. The station is located in approximately 40° N. latitude and 130° W. longitude. The elevation is about 4,560 feet above sea level.

DESCRIPTION.

The Akron Field Station contains 227 acres. Of this area, 160 acres, known as the "forestry quarter," are owned by the Colorado

FIG. 3.—Buildings of the Akron Field Station. Native vegetation is shown in the foreground. (From a photograph lent by the Office of Exhibits, U. S. Department of Agriculture.)

Agricultural Experiment Station and are used by the Bureau of Plant Industry of the United States Department of Agriculture in accordance with the terms of a cooperative agreement. The legal description of this land is the "NE. ¼ section 12, township 2 N., range 52 W." Sixty-seven acres lying directly south of the forestry quarter are controlled by the Department of Agriculture through the Office of Dry-Land Agriculture Investigations. The buildings at the station are shown in figure 3.

The surface of the farm ranges from nearly level to slightly rolling. Very little moisture is lost by run-off. There are no protecting hills or effective shelter belts. No part of the experimental area is irrigated.

The soil is a fine sandy loam. Various local names, such as "hard land" or "tight land," are given this type of soil to distinguish it from the light, sandy soils. The dark surface layer varies from 1 to 2 feet

in depth, below which the soil is light in color, due to lack of organic matter. Very little coarse gravel is present to interfere with root penetration. There is no impervious layer near enough to the surface to affect root development or water movements.

Plowing and other tillage operations are easily performed when the soil is moist but become very difficult when the moisture content is low. The fine soil particles are readily blown by the wind when surface conditions are favorable.

There is considerable variation in the soil that has been used in plat tests. Yields of the same variety on plats differently located but uniformly treated have varied from 3 to 5 bushels per acre. The experimental error that results from these variations is somewhat reduced by the shifting of plat locations from year to year. Replicated plats were used in 1915. For varieties used as checks in previous years the average yield of all plats is recorded in this bulletin.

SCOPE OF THE EXPERIMENTS.

More than 11,000 tests have been conducted during the eight years covered by this report. Of this total, 10 per cent was in field plats and 90 per cent in nursery rows. Varietal tests have been made each year. Tests of rates and dates of seeding were begun in 1911.

The number of tests has varied from year to year. In 1908 there were 315 nursery rows and 80 field plats. The number of field plats gradually increased to 185 in 1915. The number of nursery rows was increased to 2,200 in 1910 and since that time has averaged 1,187. The field-plat tests have included varietal tests of winter wheat, emmer, and rye, and of spring wheat, oats, barley, flax, proso, and grain sorghums. There have also been rate-of-seeding tests with winter wheat, spring wheat, and spring oats, and date-of-seeding tests with winter wheat.

EXPERIMENTAL METHODS.

The experiments with cereals at the Akron Field Station have been conducted in field plats and in nursery rows. Varietal tests, rate-of-seeding tests, and date-of-seeding tests have been conducted on field plats.

SIZE OF PLATS.

Most of the experiments have been conducted on tenth-acre plats. These plats are 2 rods wide by 8 rods long. They are laid out side by side in series, the plats being separated by alleys 4.62 feet wide. The different series are separated by roads 19.67 feet wide. Vegetation in the roads is controlled by frequent clipping with a mowing machine or by the use of a road grader which kills all weeds.

Throughout the period of the test it has been necessary to subdivide the tenth-acre units in at least a portion of the series in order to make sufficient divisions for all of the work being done. The subdivisions have usually been twentieth-acre plats, formed by making a 16-inch alley between the subdivisions and reducing the width of the alley between tenth-acre plats. Smaller plats are used when sufficient seed is not available to sow the standard plat. Usually no plats smaller than 0.01 acre in size are classed as field plats, but in a few instances plats containing 0.008 acre have been called field plats. Nursery rows have been used for the preliminary tests, and many varieties tested in the nursery have proved so poorly adapted to conditions that they were never grown in the field plats. Careful agronomic and physiologic observations have been made and are preserved in the form of annual reports.

REPLICATION OF PLATS.

Until 1915 only one plat of each variety was grown each year, but a leading variety of each cereal was used as a check. Usually there were five or more check plats from which the data could be averaged. In 1915 all of the leading varieties were sown in duplicate twentieth-acre plats. The value of repeating all the varieties in the experiment is apparent, and more extensive replication is planned for the future.

SOIL TREATMENT.

In preparing the land for experimental tests the aim has been to conform as closely to farm practice as possible. The plowing has been done at the moderate depth of 5 to 7 inches, and subsequent treatment has been in accord with common farm practice. The cultivation has been limited to that required to control weed growth.

Most of the experimental work has been conducted on land summer-fallowed the previous year. This was done to keep the land uniform and to assist in the control of weed growth. When the experiments were begun, summer fallowing was thought to be the most profitable method of production. In 1914 the spring-wheat varieties were grown on land which had been cropped to corn the previous year. Oats have been grown following potatoes or fallow.

The usual practice in summer fallowing has been to plow in the spring and pack with the disk harrow. Weeds were kept in check during the summer by two or three subsequent diskings. Usually the last treatment immediately preceded the sowing of the grain, either in the fall or the spring.

Rate-of-seeding and date-of-seeding tests were included in the same series of plats as the varietal work and were on land receiving the same soil treatment.

RATES AND DATES OF SEEDING.

The rate of seeding for wheat, oat, and barley varieties was 4 pecks per acre in the first year, 1908. Since 1908 the rate of seeding for wheat has been 3 pecks per acre. Barley was sown at the rate of 3 pecks per acre in 1909 and 1910, and for the remaining time at the rate of 4 pecks per acre. The rate of seeding for oats was 3 pecks per acre from 1909 to 1912. In 1913 the rate for oats was increased to 4 pecks, which was continued in 1914 and 1915. The date of seeding has varied with seasonal conditions. Table VIII gives the dates of sowing for each of the more important cereals in the 8-year period, 1908 to 1915, inclusive. Spring grains have been sown as early as the seed bed could be put in condition to receive the seed.

TABLE VIII.—*Dates on which varieties of winter wheat, spring wheat, spring oats, and spring barley have been sown in each of the eight years, 1908 to 1915, inclusive, at the Akron Field Station, Akron, Colo.*

Crop year.	Cereal group.				Crop year.	Cereal group.			
	Winter wheat.	Spring wheat.	Spring oats.	Spring barley.		Winter wheat.	Spring wheat.	Spring oats.	Spring barley.
1908.....	Nov. 5	Apr. 12	Apr. 12	Apr. 12	1912.....	Sept. 11	Apr. 11	Apr. 16	Apr. 15
1909.....	Sept. 23	Apr. 26	Apr. 26	Apr. 25	1913.....	Sept. 30	Apr. 5	Apr. 17	Apr. 18
1910.....	Sept. 27	Mar. 18	Mar. 19	Mar. 31	1914.....	Sept. 26	Mar. 24	Mar. 30	Mar. 31
1911.....	Sept. 6	Mar. 16	Mar. 17	Apr. 7	1915.....	Sept. 16	Apr. 14	Apr. 17	Apr. 19

NURSERY EXPERIMENTS.

The nursery tests at Akron have included newly introduced varieties and those of which there was not sufficient seed for sowing in field plats and also pure-line selections from the better varieties. The tests of selections have been the largest feature of the nursery work. The varieties and selections have been grown in short rows, usually from 5 to 25 feet in length. It is possible in the nursery to test economically a very much larger number of varieties and strains than could have been included in field-plat tests.

Over 250 separate named or numbered varieties of cereals have been grown in nursery rows. Wherever the performance was such as to indicate a possible superior or promising variety it was increased for further tests in field plats. The greater portion of the varieties tested proved inferior and have been discarded. A few are now being grown in field plats.

Much more work has been done in an attempt to isolate superior races from varieties. A large number of heads were selected from plants in the field plats. The following season the grains from each head were sown in a short nursery row called a head row. Notes were taken during the growing season, and the more promising races

were grown the following season in longer rows. In the longer rows the race was checked against the parent variety or some other variety used as the standard. After one or two seasons' test, all those that failed to excel the check were discarded. Several hundred selections have been tested in this way.

At first it was thought that further improvement might result from selection within pure lines. Several hundred selections were made, but no superior races have been isolated and the practice has been discontinued.

Races that proved superior in nursery rows were sown in increase plats in order to get seed for advancing the test to field plats. A few of the races thus isolated now rank with the best varieties in their respective groups.

INTERPRETATION OF EXPERIMENTAL RESULTS.

The best variety or method of culture is the one which on the average will produce the highest acre value at the least cost. None of the varieties or methods of culture tested have fulfilled all these requirements for each of the years tested. Some varieties have held secondary positions for two or three years, and yet in the average for the 8-year period they rank among the first. The best variety or method, presumably, is that one which gives the best average during a series of years, provided the seasons are representative. In actual practice, however, the problem is more complicated than would appear from this statement. The variation in soil from place to place, the changes in climatic factors from year to year, and especially at critical times during the period of cereal growth, and the adaptability of the different varieties to the changing conditions must all be taken into account.

EXPERIMENTS WITH WHEAT.

Experiments with wheat at the Akron Field Station have included plat and nursery tests of both winter and spring varieties. In addition to varietal tests there have been date-of-seeding and rate-of-seeding experiments with winter wheat and rate-of-seeding experiments with spring wheat.

Wheat has occupied a major position in the cereal tests. It is the cash crop of the district. Its acre value is equal to or greater than that of other cereals, and there is always a market for the grain. Considerable time has been devoted to developing improved strains. Two or three of the hundreds of selections made are proving superior to the parent stocks. The work of first importance, however, has been the testing of varieties.

WINTER WHEAT.

Winter wheat has been more profitable in this section than spring wheat. The most important varieties are the hard red winter wheats belonging to the Crimean or Turkey group. Six varieties have been grown continuously since the Akron Field Station was established in 1907. Rate-of-seeding and date-of-seeding experiments were started in 1911. Kharkof is the variety that has been used in these tests. An excellent field of winter wheat in the vicinity of the station is shown in figure 4.

VARIETAL EXPERIMENTS.

Experiments with winter wheat have been conducted both on field plats and in the nursery. These will be discussed separately.

PLAT EXPERIMENTS.

The winter-wheat varieties have been sown each year on land prepared by clean summer fallow. The date of seeding has varied

FIG. 4.—Winter wheat in shock on a farm in the vicinity of the Akron Field Station, 1912.

because of weather conditions. Table VIII gives the dates on which sowing commenced each year. Except in the fall of 1907, the sowing has been done in September. The rate of seeding was 4 pecks per acre in 1907 and 3 pecks per acre in the following years. No fixed depth of seeding has been used. The object has been to sow the seed in moist soil, and in dry seasons this means 2 or 3 inches below the surface. Table IX shows the annual and average yields of 17 varieties of winter wheat grown at the Akron Field Station within the 8-year period, 1908 to 1915, inclusive.

In the fall of 1907 the winter-wheat varieties were sown on land which had been broken the previous summer. Although the seed was sown late (Nov. 5), a good stand was obtained, and the varieties adapted to this part of the Plains gave fair yields. A number of varieties which failed completely are not included in Table IX.

In the fall of 1908 the seed was treated with formaldehyde solution for smut. The germination was slow. Counts for stand were not

made in the fall, but some plats were recorded as having good stands. The causes for the failure shown by zero yields in 1909 are not apparent. The formaldehyde treatment was charged with the failure at the time, but winterkilling was more probably the cause. Enough seed was obtained from most of the varieties for resowing. The crop was not sufficiently large, however, to pay the cost of harvesting, and for that reason the yields are recorded as zero. This year is included in calculating the average yields.

TABLE IX.—*Annual and average yields of 17 varieties of winter wheat grown at the Akron Field Station, Akron, Colo., in the 8-year period, 1908 to 1915, inclusive.*

Group and variety.	C. I. No.	Yield per acre (bushels).									
		1908	1909	1910	1911	1912	1913	1914	1915	Average.	
										All years grown.	Six years, 1910 to 1915.
Crimean:											
Alberta Red	2979	21.1	0	.....	12.5	.....	17.8	31.1	31.3	19.0	.....
Beloglina	1543	.....	0	23.6	.....	.....	12.5	24.5	18.4	19.8	.....
Crimean	1432	19.2	.....	.....	.....	.....	.....	.....	.....	.....	.....
Do	1436	19.1	0	38.3	17.9	33.1	12.6	28.3	26.6	22.0	26.1
Do	1437	14.6	0	34.8	13.3	32.5	14.0	25.3	26.6	20.2	24.3
Do	1559	.....	.....	36.9	11.5	32.7	17.0	39.6	29.0	27.8	27.8
Kharkof	1442	20.6	0	27.9	10.0	34.3	16.1	26.6	27.5	20.4	23.7
Do	1583	19.3	0	29.8	14.2	37.5	16.6	25.9	29.2	21.6	25.5
Kharkof, 6 P4	4207	.....	.....	.....	10.3	33.2	18.5	26.1	28.3	23.3	.....
Malakof	2908	.....	.....	26.8	17.3	35.4	18.1	30.1	30.5	26.4	26.4
Torgova	1539	.....	.....	20.6	.....	.....	.....	.....	.....	20.6	.....
Turkey	1558	15.8	.....	.....	.....	.....	.....	.....	.....	.....	.....
Do	1571	19.8	0	29.5	11.5	43.2	7.3	25.1	28.1	20.6	24.1
Do	2998	.....	.....	.....	.....	28.8	6.8	25.0	23.3	21.0	.....
Miscellaneous:											
Buffum No. 17	3330	.....	.....	.....	.....	17.5	6.5	13.8	26.6	16.1	.....
Diehl Mediterranean	1395	10.4	0	37.1	8.9	.....	12.8	30.5	26.4	18.0	.....
Ghirka Winter	1438	15.6	0	38.5	15.8	38.3	17.3	24.0	22.8	21.5	26.1

The yields in 1910 were high, due to the favorable distribution of precipitation. In 1911 a lack of moisture caused the lowest yields of any of the years for which yields are recorded. The average yield of all varieties of the Crimean group in 1911 was 12.7 bushels per acre.

The year 1912 again gave high yields, the average for the Crimean group being 34.5 bushels per acre. This is 4 bushels more than the next highest yield, 30.5 bushels per acre, produced in 1910.

The crops of 1914 and 1915 were only of ordinary size. It is well to note that the yield of grain was not increased in proportion to the increased rainfall of the year 1915. This is due to unfavorable distribution, which resulted in a lack of moisture during ripening.

Six varieties have been tested during the 8-year period. Of these, Crimean (C. I. No. 1436) has given an average yield of 22 bushels per acre. The second in rank is Kharkof (C. I. No. 1583), with an average yield of 21.6 bushels. In 1910 two varieties of promise were intro-

duced. These are Crimean (C. I. No. 1559) and Malakof (C. I. No. 2908). In the six years they have been grown these two varieties have given higher average yields than any of the others. Ghirka Winter (C. I. No. 1438) and Crimean (C. I. No. 1436) have tied for third place in the 6-year period.

In Table X agronomic data are given for five varieties which have been grown during the 8-year period. These data include average dates of heading and ripening, height, weight per bushel, and yield of grain. There is very slight difference shown in the average dates of heading and ripening, but there is a difference in the average length of straw, Ghirka Winter (C. I. No. 1438) having an average height of 39 inches and Crimean (C. I. No. 1436) an average height of 32 inches. The difference in weight per bushel is slight.

TABLE X.—*Average dates of heading and ripening, height, weight per bushel, and yield per acre of five leading varieties of winter wheat grown at the Akron Field Station, Akron, Colo., during the 8-year period, 1908 to 1915, inclusive.*

Variety.	C. I. No.	Average date—		Height.	Weight per bushel.	Yield per acre.
		Headed.	Ripe.			
				Inches.	*Pounds.*	*Bushels.*
Crimean	1436	June 18	July 13	32	58.4	22.0
Kharkof	1583	June 17	July 14	35	58.3	21.6
Ghirka Winter	1438	June 18	July 16	39	58.8	21.5
Turkey	1571	June 17	July 15	35	58.2	20.6
Kharkof	1442	...do.....	July 14	35	58.3	20.4

NURSERY EXPERIMENTS.

The cereal nursery has made possible the testing of a large number of varieties and strains. Sixty-three varieties have been tested in nursery rows, most of which have not shown sufficient promise to warrant advancing them to field tests. A much larger number of pure-line selections have been tested in the nursery and most of them discarded. One of the strains has been increased and is worthy of mention. It is a selection of Kharkof (C. I. No. 1442) and has been designated Kharkof 6P4 (C. I. No. 4207).

Nursery sowings have suffered from soil blowing to such an extent that the results are not entirely comparable. In 1914 several rows were almost entirely killed. Soil blowing follows as a consequence of the special soil preparation necessary in order to sow by hand or with garden tools. In order to prevent soil blowing it is necessary to have an uneven and, if possible, a lumpy surface.

RATE-OF-SEEDING EXPERIMENTS.

Rate-of-seeding tests of Kharkof winter wheat have been conducted at Akron for five years. During that time four rates of seeding have been used each year. The seed has been sown on summer-fallowed

land at the same time as the varietal tests. The results are shown in Table XI.

TABLE XI.—*Annual and average yields of Kharkof winter wheat in a rate-of-seeding test at the Akron Field Station, Akron, Colo., 1911 to 1915, inclusive.*

Rate of seeding per acre.	Yield per acre (bushels).					
	1911	1912	1913	1914	1915[a]	Average.
2 pecks	9.6	38.0	18.3	18.3	30.5	23.1
3 pecks	10.4	44.0	15.3	24.0	33.0	25.3
4 pecks	12.8	39.3	16.3	24.3	32.5	25.0
5 pecks	13.8	38.3	18.6	37.3	34.2	28.4
6 pecks	.....	.....	18.6	27.3	34.5	26.6

[a] Average of two varieties, Crimean (C. I. No. 1559) and Kharkof (C. I. No. 4207).

The results recorded in Table XI are not satisfactory or conclusive. It is thought that soil variations have interfered with the test to some extent. The maximum yield has varied from one rate to another as the seasons have varied. More data are needed before conclusions can be drawn. It will be noted that the 4-peck rate gave an average yield less than either the 3-peck or the 5-peck rate. The 5-peck rate gave the highest average yield. This rate produced the best yield in 1911, when there was a scarcity of moisture, and in 1915, when moisture was plentiful. In 1912, however, the 3-peck rate gave a yield 4.2 bushels higher than the 4-peck rate and 5.2 bushels more than the 5-peck rate. During the last three years a 6-peck rate has been included. The average shows a slight decrease in yield as compared with the lighter seedings. At present the data are contrary to what farmers believe to be the best rate to sow to obtain maximum yields.

DATE-OF-SEEDING EXPERIMENTS.

An experiment to determine the best date to sow winter wheat was begun in 1911. In 1912 the test was not conducted, on account of the dry condition of the seed bed at the time of sowing. It has not been possible to sow on the same date each year and therefore the time has been divided into 15-day periods. The test has been made on summer fallow. The rate of seeding has been 3 pecks per acre. It has been difficult to make sowings earlier than September 15 and snow and frost usually prevent seeding after November.

The annual and average yields obtained in this test during four years, 1911, 1913, 1914, and 1915, are given in Table XII. The experiment has not been conducted long enough to establish any fact, but the figures indicate that the best time to sow winter wheat to get maximum yields is between September 15 and October 15.

TABLE XII.—*Annual and average yields of Kharof winter wheat in a date-of-seeding test at the Akron Field Station, Akron, Colo., in 1911, 1913, 1914, and 1915.*

Date of seeding.	Yield per acre (bushels).				
	1911	1913	1914	1915	Average.
Sept. 16 to 30, inclusive	15.5	15.6	26.0	27.3	21.1
Oct. 1 to 15, inclusive	16.1	15.6	26.6	34.2	23.1
Oct. 16 to 31, inclusive	.....	12.6	11.3	25.8	[a]16.6
Nov. 1 to 30, inclusive	16.5	8.6	13.6	26.6	15.1

[a] Three-year average.

The sowings made during the first 15 days in October have given yields as high as or higher than those from any other date of seeding during the last three years of the test. In 1911 an early sowing (Sept. 6) gave the highest yield, 16.8 bushels, and a late sowing (Nov. 11) ranked second. The average of the yields from sowings made between September 15 and October 15 is 22.1 bushels, which is 5.5 bushels higher than the yield from sowings made during the following 15-day period.

SPRING WHEAT.[1]

Spring wheat is an important crop in this section of the Great Plains. It can be sown early on land prepared during the late fall. It has given good yields when conditions were favorable. The varieties which have given the highest yields are durum wheats. In addition to the varietal experiments, a rate-of-seeding test has been conducted with Arnautka durum wheat since 1911.

VARIETAL EXPERIMENTS.

Experiments with spring wheat have been conducted both on field plats and in the nursery. These will be discussed separately.

PLAT EXPERIMENTS.

A total of 44 varieties of spring wheat have been grown in field plats for one year or more. Table XIII shows the annual and average yields of these varieties, arranged in groups according to their relationships.

Seven varieties of durum wheat have been grown continuously during the eight years. Pelissier (C. I. No. 1584) has given the highest average yield, 22.4 bushels per acre. Velvet Don (C. I. No. 1445) ranks second, and Arnautka (C. I. No. 1493) is third. The fourth variety in rank is the Galgalos (C. I. No. 2398), a soft white common wheat which belongs to none of the groups grown commercially. Arnautka 6P1 (C. I. No. 4064) has given an average yield of 27.6 bushels per acre for the six years in which it has been grown.

[1] For a discussion of the groups and varieties of hard spring wheat, see Ball, C. R., and Clark, J. A., Varieties of hard spring wheat. U. S. Dept. Agr., Farmers' Bul. 680, 20 p., 7 fig. 1915.

It is a selection from Arnautka (C. I. No. 1494). If the data for the parent variety and the selection are combined, the average yield in the 8-year period is 24.5 bushels, which would give it first rank. At the present time the difference in yield in favor of any one variety is not sufficient to be conclusive. A plat of durum wheat at the station is shown in figure 5.

TABLE XIII.—*Annual and average yields of 44 varieties of spring wheat grown at the Akron Field Station, Akron, Colo., in the eight years, 1908 to 1915, inclusive.*

Group and variety.	C.I. No.	Yield per acre (bushels).									
		1908	1909	1910	1911	1912	1913	1914	1915	Average. All years grown.	Average. 8-year period.
DURUM WHEATS.											
Kubanka:											
Arnautka	1493	26.9	20.8	16.6	10.6	27.5	10.5	27.6	27.9	21.1	21.1
Do	1494	18.7	11.8	.....	.....	.....	.....	.....	.....	15.3	.....
Do	1547	19.0	.....	.....	.....	.....	.....	.....	.....	.....	.....
Arnautka 6P1	4064	.....	.....	19.5	15.7	37.3	10.6	25.0	27.6	27.6	.....
Beloturka	1520	31.1	19.4	19.9	8.0	21.1	10.6	19.5	26.7	19.5	19.5
Gharnovka	1447	29.1	20.9	[a]13.1	9.3	36.5	3.3	27.7	22.2	20.3	20.3
Kubanka	1354	27.2	18.0	21.3	11.7	19.8	13.6	22.7	.....	19.2	.....
Do	1440	26.8	9.3	17.1	9.0	25.1	5.1	20.7	27.6	17.6	17.6
Do	1516	.....	.....	.....	9.1	30.0	6.0	26.5	31.3	20.6	.....
Do	2246	14.8	.....	.....	.....	.....	.....	.....	.....	.....	.....
Do	2882	13.9	.....	.....	.....	.....	.....	.....	.....	.....	.....
Marouani	1593	22.9	14.2	19.3	10.6	19.0	14.1	24.0	.....	17.7	.....
Pererodka	1350	29.2	15.9	11.5	.....	.....	.....	.....	.....	18.8	.....
Taganrog	1570	20.0	.....	.....	.....	.....	.....	.....	.....	.....	.....
Pelissier:											
Pelissier	1584	24.7	23.6	15.8	10.6	35.6	10.5	26.6	31.6	22.4	22.4
Velvet Don:											
Velvet Don	1445	33.3	21.1	13.5	10.0	33.3	7.3	25.3	28.1	21.5	21.5
Kahla:											
Bledur	1471	15.4	16.8	17.7	10.6	33.0	8.3	26.3	33.6	20.2	20.2
Purple	3024	24.8	20.8	15.3	7.9	33.0	10.0	21.2	.....	19.0	.....
Miscellaneous:											
Adjini	2941	19.5	12.3	.....	.....	.....	.....	.....	.....	15.9	.....
Medeah	1597	17.8	13.7	.....	.....	.....	.....	.....	.....	15.8	.....
COMMON WHEATS.											
Fife:											
Cole Hybrid	4062	11.8	27.9	21.5	12.3	18.2	8.0	21.0	.....	17.2	.....
Ghirka	1517	20.6	23.8	18.8	8.5	23.3	11.6	19.3	22.6	18.6	18.6
Glyndon (Minn. No. 163)	2873	.....	.....	.....	9.4	17.3	8.0	16.6	16.2	13.5	.....
Marquis	3641	.....	.....	.....	.....	.....	7.5	19.7	26.5	17.9	.....
Power	3025	22.5	.....	.....	.....	.....	.....	.....	.....	.....	.....
Rysting	3022	19.3	.....	.....	.....	.....	.....	.....	.....	.....	.....
Bluestem:											
Bolton	3023	20.4	.....	.....	.....	.....	.....	.....	.....	.....	.....
Haynes (Minn. No. 169)	2874	.....	.....	.....	.....	.....	.....	.....	16.4	.....	.....
Do	3020	25.2	15.3	19.8	.....	.....	.....	.....	.....	20.1	.....
Haynes (Minn. No. 51)	3021	24.0	.....	.....	.....	.....	.....	.....	.....	.....	.....
Preston:											
Erivan	2397	19.3	26.3	15.2	11.9	20.7	12.0	19.3	19.5	18.0	18.0
Fretes	1596	10.3	.....	.....	.....	.....	.....	.....	.....	.....	.....
Pioneer	4324	.....	.....	.....	.....	.....	.....	.....	28.7	.....	.....
Preston	3081	.....	.....	.....	.....	.....	.....	.....	26.2	.....	.....
Do	3087	9.6	18.3	.....	.....	.....	.....	.....	.....	14.0	.....
Red Russian	4141	.....	15.2	15.6	12.1	23.2	8.3	23.0	23.9	15.2	.....
Miscellaneous:											
Galgalos	2398	21.8	19.8	20.5	19.6	20.5	14.1	21.7	24.4	20.3	20.3
Manchuria	2492	18.2	23.3	[b]25.0	.....	.....	.....	.....	.....	21.2	21.9
Mexican No. 1	3035	7.5	.....	.....	.....	.....	.....	.....	.....	.....	.....
Prelude	4323	.....	.....	.....	.....	.....	.....	.....	29.5	.....	.....
Rieti	2942	3.0	.....	.....	.....	.....	.....	.....	.....	.....	.....
Sonora	1946	16.7	.....	.....	.....	.....	.....	.....	.....	.....	.....
Unnamed	2949	.4	.....	.....	.....	.....	.....	.....	.....	.....	.....
Do	4377	.....	.....	.....	.....	.....	8.6	22.0	.....	15.3	.....

[a] Yield computed from 0.004 acre.

[b] Actual yield from 0.004 acre.

In the Fife group, Ghirka Spring is the only variety that has been grown during the entire eight years. It has given a lower yield than the durums, and Table XIV shows that the weight per bushel is about 2 pounds less. The Bluestem group has not been tested extensively, but the yields obtained are not especially promising. The

FIG. 5.—Plat of Beloturka durum wheat (C. I. No. 1520) at the Akron Field Station, 1910.

varieties of the Preston group have shown their ability to yield well in dry seasons, but the average for the eight years is low. Table XIV shows that Erivan (C. I. No. 2397) has been ripe an average of four days before any other variety, but the average weight per bushel is only 56 pounds.

TABLE XIV.—*Average agronomic data, yields per acre, and weights per bushel for eight varieties of spring wheat grown at the Akron Field Station, Akron, Colo., during the 8-year period, 1908 to 1915, inclusive.*

Group and variety.	C. I. No.	Average date—		To maturity from—		Height.	Yield per acre.	Weight per bushel.
		Headed.	Ripe.	Planting.	Heading.			
DURUM WHEATS.								
Kubanka:				*Days.*	*Days.*	*Inches.*	*Bush.*	*Pounds.*
Arnautka	1493	June 30	July 30	110	30	36	21.1	61.6
Do[1]	4064	June 29	...do...	109	31	38	24.5	60.9
Beloturka	1520	June 28	July 27	109	27	37	19.5	61.1
Kubanka	1440	June 30	July 28	110	28	33	17.6	61.0
Pelissier:								
Pelissier	1584	June 29	July 31	111	31	35	22.4	60.2
COMMON WHEATS.								
Fife:								
Ghirka	1517	July 2	July 29	108	27	30	18.6	58.7
Preston:								
Erivan	2397	June 30	July 25	102	25	27	18.0	56.0
Miscellaneous:								
Galgalos	2398	June 29	July 29	109	30	24	20.3	57.4

[1] Yields of Arnautka (C. I. No. 1494) used for 1908 and 1909.

Table XIV shows the average dates when the varieties were fully headed and ripe, the length of time from sowing to maturity and from heading to maturity, the average height at maturity, the yield per acre, and the weight per bushel.

The data in Table XIV show that three varieties of durum wheat have averaged at least 61 pounds per bushel. None of the common wheats has averaged more than 57.8 pounds per bushel. The durum varieties have longer straw, which is valuable on account of the difficulty in harvesting grain with short straw. The weather conditions usually force a rapid maturity of all varieties. The result is that the time from sowing to maturity is very uniform. It may be noted that Arnautka, which matures two days later than Kubanka, is recorded as requiring the same number of days from sowing to maturity. The explanation is that the date of sowing was not the same.

NURSERY EXPERIMENTS.

About fifty varieties and several hundred selections of spring wheat have been grown in nursery rows. The object has been to test varieties of unknown value and selections or strains in short nursery rows before giving them space in field plats. If they did not show promise, they were discarded. Some promising selections have been increased for testing in field plats. One of the best of these is Arnautka 6P1, which has been referred to in the discussion of field-plat experiments. Several selections which yielded well in nursery rows failed to outyield the mother variety when grown in field plats and so have been discarded.

RATE-OF-SEEDING EXPERIMENTS.

Rate-of-seeding tests, including four different rates, have been conducted at Akron for five years with durum wheat. Table XV gives the yield data obtained, which show a great lack of consistency. It will be noted that the general trend of increase in 1911 and 1913 was from the lower to the higher rates. These were dry years, when agricultural experience would have favored the reverse order. In 1912, with more abundant moisture, there is a decrease from 41 bushels for the low rate to 27 bushels for the high rate. This, again, is contrary to common belief. In 1914, with a fair rainfall, the order is normal, as gauged by common opinion. In 1915 the yields from the 2-peck rate and from the 6-peck rate are practically the same, and there is very little difference in the yields from all rates. The greatest departure was 0.7 bushel per acre. Under these conditions the average for the five years can not carry much weight. The average for the 2-peck rate is 21.2 bushels, and that for the 5-peck rate is the same. The data seem to indicate that within certain limits the rate does not materially affect the yield.

TABLE XV.—*Annual and average yields of durum wheat in a rate-of-seeding test at the Akron Field Station, Akron, Colo., 1911 to 1915, inclusive.*

Rate of seeding (per acre).	Yield per acre (bushels).						
	1911	1912	1913	1914	1915	Average. 1911 to 1915.	Average. 1912 to 1915.
2 pecks	9.9	41.0	7.3	18.0	30.0	21.2	24.1
3 pecks	9.8	37.3	8.6	19.6	29.5	21.0	23.7
4 pecks	10.8	37.0	11.0	20.0	29.5	21.7	24.4
5 pecks	12.6	30.3	11.6	22.0	29.5	21.2	23.3
6 pecks	.....	28.3	11.2	21.3	30.2	.....	22.7
7 pecks	.....	27.0	11.6	21.0	.....	.....	.....

COMPARISON OF WINTER AND SPRING WHEAT.

It is of importance to know whether winter or spring wheat will give the best returns. Table XVI shows the annual and average yields of nine varieties of winter and spring wheat grown on the

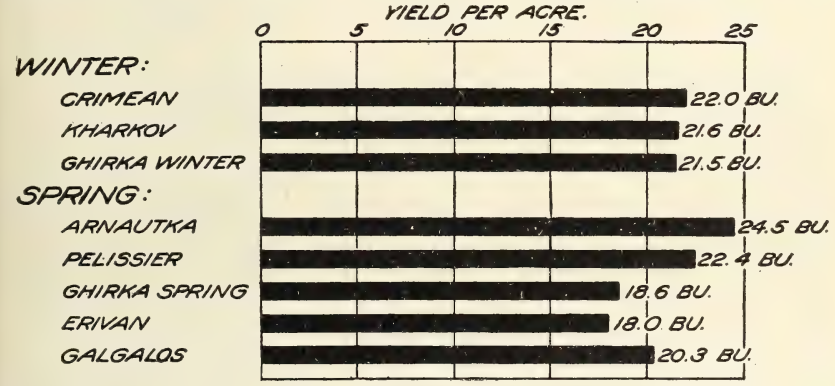

FIG. 6.—Diagram showing the average yields of the leading varieties of wheat at the Akron Field Station, 1908 to 1915, inclusive.

Akron Field Station during the eight years, 1908 to 1915, inclusive. Figure 6 shows the average yields in graphic form.

TABLE XVI.—*Annual and average yields of nine varieties of wheat grown at the Akron Field Station, Akron, Colo., during the 8-year period, 1908 to 1915, inclusive.*

Variety.	C. I. No.	Yield per acre (bushels).								
		1908	1909	1910	1911	1912	1913	1914	1915	8-year average.
Winter varieties:										
Crimean	1436	19.1	0	38.3	17.9	33.1	12.6	28.3	26.6	22.0
Kharkof	1583	19.3	0	29.8	14.2	37.5	16.6	25.9	29.2	21.6
Ghirka Winter	1438	15.6	0	38.5	15.8	38.3	17.3	24.0	22.8	21.5
Spring varieties:										
Arnautka	1494, 4064	18.7	11.8	19.5	15.7	37.3	10.6	25.0	27.6	24.5
Pelissier	1584	24.7	23.6	15.8	10.6	35.6	10.5	26.6	31.6	22.4
Arnautka	1493	26.9	20.8	16.6	10.6	27.5	10.5	27.6	27.6	21.1
Galgalos	2398	21.8	19.8	20.5	19.6	20.5	14.1	21.7	24.4	20.3
Ghirka Spring	1517	20.6	23.8	18.8	8.5	23.3	11.6	19.3	22.6	18.6
Erivan	2397	19.3	26.3	15.2	11.9	20.7	12.0	19.3	19.5	18.0

The yields of two varieties of durum wheat have averaged slightly higher than those of the best winter variety. However, in the case of the winter variety there was one year of failure, which may not occur again in a long series of years. If this is true, the winter wheat will probably take first rank. It should also be noted that when winter wheat winterkills, the land can be resown to spring wheat. The winter wheat should then be credited with the returns from the spring wheat grown on the land that year, less the cost of seed and sowing. If this were done for the year of failure in Table XVI it would place winter-wheat yields above those of spring wheat. At present there is probably greater value represented in the slightly lower yield of winter wheat on account of the higher market price. In case the grain is ground and used for feed the market price would not be a factor.

In 1908 the durum wheats produced about 25 per cent more grain than the winter wheats, while the common spring wheats gave yields about equal to the winter varieties. In 1909 the spring wheats yielded well and winter wheats failed. In 1910 winter wheats produced nearly double the yields of spring wheat. In 1911 the winter-wheat yields were about 50 per cent higher than those of any of the spring varieties except Galgalos, which yielded 1.7 bushels per acre more than the best winter variety. In 1912 the winter-wheat yields averaged about 40 per cent more than the spring-wheat yields. In 1913, 1914, and 1915 the differences were not great.

To summarize: In 1909 spring wheat gave good yields, while winter wheat was a failure; in 1910, 1911, and 1912 the winter-wheat yields were distinctly larger than those of spring wheat; while in 1908, 1913, 1914, and 1915 the differences were not great. For the eight years, the average yields of the winter varieties and durum spring varieties are about equal, while the spring commons are 2 to 3 bushels lower. When all the facts are considered, it appears that winter wheat will return more value per acre than spring wheat.

EXPERIMENTS WITH OATS.

The better varieties of oats have made fair yields at the Akron Field Station in all except one of the eight years during which they have been tested. In 1911 the yields were low except that of Colorado No. 37 (C. I. No. 619), which was located on a plat that received some extra water from run-off. Four varieties have been grown during the entire eight years. The average yield of these four varieties was 42.5 bushels per acre. They include two early and two midseason varieties. The average yield of the midseason group is slightly larger than that of the early group.

VARIETAL EXPERIMENTS.

Varietal experiments with oats have been conducted both in field plats and in the nursery.

PLAT EXPERIMENTS.

Fifteen varieties and several strains of spring oats have been grown in field plats. One of the strains shows some promise and is reported in this bulletin. Others have failed to produce yields superior to those of the parent varieties and have been discarded. No variety of the late groups has been grown continuously. Table XVII shows the annual and average yields of the 16 varieties and strains grown on the Akron Field Station in the 8-year period from 1908 to 1915, inclusive. They have been divided into three groups, according to the time of maturity.

TABLE XVII.—*Annual and average yields of 16 varieties and strains of oats grown at the Akron Field Station, Akron, Colo., 1908 to 1915, inclusive.*

Group and variety.	C. I. No.	Yield per acre (bushels).									
		1908	1909	1910	1911	1912	1913	1914	1915	Average.	
										Eight years.	All years grown.
Early:											
Burt	293	.....	.....	.....	.....	48.2	36.8	63.1	82.6	.....	57.4
Kherson	459	52.8	33.1	37.1	12.4	36.0	36.1	65.0	85.0	44.7	44.7
Perm	170	.....	.....	.....	2.0	34.5	20.6	50.5	78.0	.....	37.1
Sixty-Day	165	42.9	37.2	21.9	3.3	33.4	28.1	65.0	82.6	39.3	39.3
Sixty-Day, 4P2	788	.....	.....	32.0	4.2	40.0	26.2	61.2	74.2	.....	39.6
Midseason:											
Canadian	444	19.2	53.1	29.4	.....	.....	.....	.....	.....	.....	25.4
Colorado No. 37	619	36.8	55.6	29.9	32.5	30.9	32.5	53.7	79.2	43.9	43.9
Danish	441	40.8	.....	.....	.....	.....	.....	.....	.....	.....	.....
Early Champion	.....	41.8	25.0	34.8	.....	.....	.....	.....	.....	.....	33.9
Lincoln	738	.....	.....	.....	.....	.....	41.2	61.2	67.8	.....	56.9
Red Rustproof	451	.....	.....	20.8	.....	.....	.....	.....	.....	.....	.....
Silvermine	659	.....	.....	.....	.....	.....	38.1	42.5	.....	.....	40.3
Swedish Select	134	62.5	50.6	29.5	15.9	30.9	27.5	48.7	69.4	41.9	41.9
Late:											
White Tartarian	300	19.7	.....	.....	.....	23.4	23.7	42.1	65.0	.....	34.8
White Russian	551	18.8	.....	.....	.....	.....	.....	.....	.....	.....	.....
Yellow Giant	342	19.2	.....	.....	.....	.....	.....	.....	.....	.....	.....

As shown in Table XVII, the Kherson (C. I. No. 459) has an average yield of 44.7 bushels per acre for the 8-year period. The variety ranking second is Colorado No. 37 (C. I. No. 619) in the midseason group. Its average yield is 43.9 bushels. When deduction is made for the favorable location of Colorado No. 37 in 1911, the average yield becomes the same as that of Swedish Select (C. I. No. 134), 41.9 bushels. The Sixty-Day variety (C. I. No. 165) has yielded less than the Kherson variety in all years except 1909. Its average yield of 39.3 bushels per acre is 5.4 bushels less than that of the Kherson. The selection of the Sixty-Day variety, listed as Sixty-Day 4P2, seems to be just about equal to the parent variety. A

plat of a pure-line selection of Sixty-Day oats is shown in figure 7. The Burt oat (C. I. No. 293) has been grown only four years. In these years it has averaged 57.9 bushels, as compared with 55.5 bushels from the Kherson variety for the same period.

In the fall of 1907 a plat of Boswell Winter oats was sown. While the winter survival was low, the plat yielded at the rate of 15.7 bushels per acre. Seed of this variety has been sown five other years, and each time the plants have entirely winterkilled.

FIG. 7.—Plat of a pure-line selection of Sixty-Day oats at the Akron Field Station, with the farm buildings in the background, in 1910.

Table XVIII shows the average dates of heading and maturity, height, weight per bushel, and yield of five varieties of oats representing all three of the spring groups. The White Tartarian was not grown in 1909, 1910, and 1911. The average yields are shown graphically in figure 8.

TABLE XVIII.—*Average dates of heading and maturity, height, yield of grain and straw, and weight per bushel of five varieties of oats grown at the Akron Field Station, Akron, Colo., 1908 to 1915, inclusive.*

Group and variety.	C. I. No.	Dates of—		Height.	Yield per acre.		Weight per bushel.
		Heading.	Maturity.		Grain.	Straw.	
				Inches.	*Bushels.*	*Pounds.*	*Pounds.*
Early:							
Kherson	459	June 26	July 20	27	44.7	1,394	31.3
Sixty-Day	165	June 27	July 19	27	39.3	1,418	30.6
Midseason:							
Colorado No. 37	619	July 6	Aug. 1	31	43.9	2,014	35.0
Swedish Select	134	July 8	July 31	32	41.9	2,119	32.5
Late:							
White Tartarian [1]	300	July 11	Aug. 9	34	34.8	2,538	34.0

[1] Not grown in 1909, 1910, and 1911.

The data in Table XVIII show that the difference in date of maturity between the early and midseason and between the midseason and late groups is about 10 days. The varieties in the early group mature about July 20, those of the midseason group about July 31, and those of the late group about August 9. There is an increase of about 500 pounds per acre in the straw yield of each successively later group. As oat straw has considerable feeding value this should be taken into account. Considering yields of both grain and straw, the midseason variety, Colorado No. 37 (C. I. No. 619), has given the best returns during the period.

NURSERY EXPERIMENTS.

A total of 61 varieties and several hundred strains have been tested in nursery rows. The varieties that have shown promise have been advanced to the field tests. With the exception of Sixty-Day 4P2, they have not proved worthy of continued trial and have

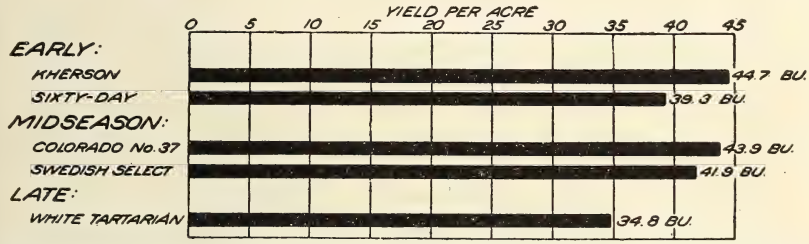

FIG. 8.—Diagram showing the average yields of the leading varieties of oats at the Akron Field Station, 1908 to 1915, inclusive.

been discarded. The nursery tests have served to eliminate a large quantity of material not adapted to the conditions at Akron. The results are of a negative rather than a positive nature.

RATE-OF-SEEDING EXPERIMENTS.

An experiment was begun in 1911 to investigate the effect of rate of seeding on the yield per acre of oats. The Kherson variety (C. I. No. 459) has been used. Table XIX shows the annual and average yields obtained during the five years.

TABLE XIX.—*Annual and average yields of Kherson oats in a rate-of-seeding test at the Akron Field Station, Akron, Colo., 1911 to 1915, inclusive.*

Rate of seeding per acre.	Yield per acre (bushels).						
	1911	1912	1913	1914	1915	Average. 1911 to 1915	Average. 1912 to 1915
2 pecks	6.9	46.9	30.0	74.4	85.0	52.1	59.1
3 pecks	10.6	61.7	23.1	71.8	86.9	50.8	60.9
4 pecks	13.1	40.0	40.6	84.4	87.5	53.1	63.1
5 pecks	13.8	43.1	25.0	65.0	90.0	47.4	55.7
6 pecks	.....	71.9	18.2	73.8	90.6	.....	63.6

What has been true of other similar tests at the Akron Field Station is true of the rate-of-seeding test with oats, namely, that the data are not consistent. In 1911, which was a dry year, there was a gradual increase in yield as the rate of seeding increased. In 1912 there was no uniform variation. The 6-peck rate yielded 71.9 bushels per acre, the 4-peck rate 40 bushels, and the 3-peck rate 61.7 bushels. In 1913 the data show an exact reverse. The 6-peck rate produced the lowest yield, the 4-peck rate the highest yield, and the 3-peck rate next to the lowest. In 1914, again, the highest yield came from the 4-peck rate, but the 3-peck and 5-peck rates are both lower in yield than the 2-peck and the 6-peck rates. In 1915 there is a return to a uniformly gradual increase in yield as the rate increases from 2 pecks to 6 pecks.

It seems probable that a part of the lack of uniformity throughout the experiment may be due to soil variation. The 4-peck rate has produced the highest average yield in the five years. The 4-year average from the 6-peck rate is highest, but two seasons of favorable rainfall are included. In the one year of low rainfall, 1913, the 6-peck rate produced less than half the yield from the 4-peck rate. The conclusion drawn from the data available at the present time is that the 4-peck rate will produce the highest yield under average conditions.

EXPERIMENTS WITH BARLEY.

In this section of the Great Plains spring barley is grown both for farm use as a feed and for market. One variety may be best adapted for feeding and another prove to be best to grow for market. Several varieties and strains of barley have been tested, and four of these, representing three groups, have been grown for eight years. The 8-year average yield of four hulled barleys is 35.9 bushels per acre. No rate-of-seeding tests have been conducted with barley.

Varietal tests of barley have been conducted on field plats and in the nursery.

PLAT EXPERIMENTS.

The varietal tests of barley have become more extensive from year to year. Table XX shows the annual and average yields of 19 varieties of barley grown at the Akron Field Station for varying periods from 1908 to 1915, inclusive.

The 2-rowed hulled group contains the Blackhull (C. I. No. 878), which has black glumes, and nine other varieties with light glumes. All of this group have beards. The 6-rowed hulled group contains Arlington Awnless (C. I. No. 702), which has light glumes and no beards; Coast (C. I. No. 690), with white glumes and long heavy beards; Horsford (C. I. No. 877), light glumes and hooded; and Gatami (C. I. No. 575), with black glumes and beards. The data show that of the varieties grown throughout the 8-year period,

Hannchen (C. I. No. 602) has produced the highest average yield per acre. Its average of 38.7 bushels is 0.7 bushel higher than that of Coast, C. I. No. 690 (formerly grown and distributed as California Feed). Hanna (C. I. No. 226) ranks third, with an average yield of 34.3 bushels. White Smyrna (C. I. No. 658) is the only variety recently introduced into the tests which shows promise of outyielding those already mentioned.

TABLE XX.—*Annual and average yields of 19 varieties of barley grown in field plats at the Akron Field Station, Akron, Colo., during the eight years from 1908 to 1915, inclusive.*

Group and variety.	C. I. No.	Yield per acre (bushels).									
		1908	1909	1910	1911	1912	1913	1914	1915	Average.	
										All years grown.	8-year period.
SPRING VARIETIES.											
2-rowed hulled:											
Blackhull	878	25.4	20.1	23.8	5.8	26.6	25.4	42.9	77.1	30.9	30.9
Hanna	21	.....	.....	23.5	12.9	43.1	18.3	40.7	72.2	35.1	.....
Do	203	.....	.....	29.2	13.1	42.1	27.2	42.5	.....	30.8	.....
Do	226	34.2	22.2	26.6	15.4	34.2	29.1	42.5	70.5	34.3	34.3
Hannchen	531	.....	.....	.....	.....	56.7	22.5	45.9	.....	41.7	.....
Do	602	47.8	20.7	28.2	10.4	34.7	22.1	59.6	86.0	38.7	38.7
Mansury	617	31.2	12.1	.....	.....	.....	.....	.....	.....	21.7	.....
Orel	351	.....	.....	.....	.....	.....	32.0	42.5	73.3	49.3	.....
Primus	532	.....	.....	32.3	2.3	17.9	6.6	42.1	.....	20.2	.....
White Smyrna	658	.....	.....	.....	27.5	35.8	20.4	70.4	80.9	47.0	.....
2-rowed naked:											
Baku [1]	709	.....	.....	.....	.....	28.6	5.4	.....	.....	17.0	.....
6-rowed hulled:											
Arlington Awnless	702	.....	.....	.....	.....	.....	22.9	41.6	.....	32.2	.....
Coast (California Feed)	690	38.6	32.8	25.5	16.7	38.5	22.5	50.5	79.1	38.0	38.0
Horsford	877	31.9	22.3	21.2	7.9	30.0	16.5	24.0	.....	25.6	.....
Gatami	575	.....	.....	.....	.....	.....	25.4	65.0	.....	45.2	.....
Manchuria	643	.....	21.5	18.4	15.2	34.6	25.4	40.0	.....	25.9	.....
6-rowed naked:											
Nepal [1]	595	31.5	26.3	19.4	0.6	18.8	6.8	41.6	56.0	25.1	25.1
Mixture:											
Composite	1147	.....	.....	.....	.....	.....	21.6	44.5	66.0	44.0	.....
WINTER VARIETY.											
6-rowed hulled:											
Tennessee Winter	257	.....	.....	5.8	9.4	15.4	19.1	.....	.....	8.3	.....

[1] Yields computed at 48 pounds per bushel; actual weight about 56 pounds.

The variety commonly called "Bald" or "White Hull-less" barley is here called Nepal, its proper name. Although naked barley has about the same bushel weight as wheat, it is here computed at 48 pounds, in order that the naked varieties may be more easily compared with the hulled ones. On this basis the yield of the Nepal variety is 25.1 bushels. Pound for pound it is more valuable than hulled barley, as the latter contains from 10 to 12 per cent of hulls. Deducting for these, the 25.1 bushels of Nepal barley is nearly equal to 28.7 bushels of hulled barley.

Winter barley has winterkilled to such an extent that the average yield is low. In two years out of six the winter barley has failed. The average yield for the six years is 8.3 bushels to the acre.

The average dates of heading and maturity, height, yield of grain and straw, and weight per bushel of five varieties of barley which were grown at the Akron Field Station during the 8-year period from 1908 to 1915, inclusive, are given in Table XXI. The average yields are shown graphically in figure 9. Blackhull (C. I. No. 878) has averaged five days earlier in maturing than Coast (C. I. No. 690). The ripening date of Blackhull is July 15, and that of Coast July 20. Hannchen (C. I. No. 602) and Hanna (C. I. No. 226) are still later, averaging July 22 and July 24, respectively.

The quality of grain, as shown by weight per bushel, puts Hannchen in the lead and Hanna a close second. Although the Coast barley has a plump, heavy grain, it does not thrash clean. The fragments

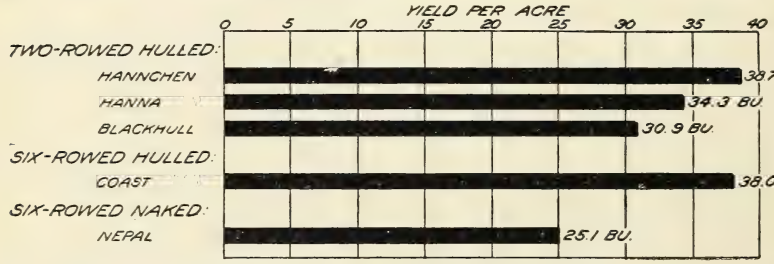

FIG. 9.—Diagram showing the average yields of the leading varieties of barley at the Akron Field Station, 1908 to 1915, inclusive.

of awns prevent its packing and the tester shows it to weigh only 39 pounds per bushel, or 9 pounds below the standard weight. The straw weights do not vary sufficiently to need comment.

TABLE XXI.—*Average dates of heading and maturity, height, yield of grain and straw, and weight per bushel of five varieties of barley grown at the Akron Field Station, Akron, Colo., during the 8-year period, 1908 to 1915, inclusive.*

Group and variety.	C. I. No.	Dates of—		Height.	Yield per acre.		Weight per bushel.
		Heading.	Maturity.		Grain.	Straw.	
				Inches.	*Bushels.*	*Pounds.*	*Pounds.*
2-rowed hulled:							
Blackhull	878	June 18	July 15	28	30.9	1,696	46.5
Hanna	226	July 2	July 24	28	34.3	2,291	47.0
Hannchen	602	June 30	July 22	26	38.7	1,973	47.5
6-rowed hulled:							
Coast (California Feed)	690	June 25	July 20	28	38.0	2,134	39.0
6-rowed naked:							
Nepal (White Hull-less)	595	June 28	July 22	26	[a] 25.1	1,771	57.8

[a] For comparison, computed at 48 pounds per bushel.

NURSERY EXPERIMENTS.

The nursery tests with barley have included 75 varieties and numerous strains. The object has been to discover valuable new material, and when a variety or selection did not prove itself supe-

rior to varieties already in field plats it was discarded. The few that have been worthy of field tests are included in Table XX. Figure 10 shows a view of the barley nursery in 1912.

EXPERIMENTS WITH MINOR CEREALS.

RYE.

Winter rye has been grown in field plats for two years on the Akron Field Station. The average yield in the two years was 26.1 bushels per acre. This is much below the wheat yields in the same years. The blooming of the flowers at a time when dry, hot winds are common causes a partial sterility of the heads and a resultant reduction in yield. At present rye is not grown as a grain crop, but as a catch crop for forage.

EMMER.

Winter emmer has been sown each of the eight years, 1908 to 1915, inclusive. The crops of 1909 and 1915 were failures. The

FIG. 10.—Barley nursery at the Akron Field Station in 1912.

highest yield, 29.5 bushels, was produced in 1908. The 8-year average yield of Black Winter emmer (C. I. No. 2337) is 14.2 bushels per acre. Good stands are usually obtained, but a high percentage of winterkilling occurs, and low yields result. Winter emmer can not be recommended for this district.

White Spring emmer (C. I. No. 1524) has given fair yields in each of the eight years it has been grown. The lowest yield, 11.1 bushels, was produced in 1910, and the highest yield, 69 bushels, in 1915. The average acre yield has been 30.3 bushels. Spring emmer is therefore a fair producer, but it has not been a close competitor of either wheat or barley.

FLAX.

Flax has been sown in each of the eight years during which experiments have been conducted at Akron. In the three years, 1911, 1914, and 1915, the crop failed. Russian (C. I. No. 19) has been grown throughout the 8-year test. The highest yield recorded was 13.1 bushels per acre, produced in 1912. Other varieties have been grown for shorter periods, but none has proved superior to the Russian. The 8-year average yield of this variety is 4.4 bushels per acre.

PROSO.

Proso, commonly called hog millet or broom-corn millet, has not been given a very thorough test. It has been grown in nursery rows and small plats, but continuous field-plat tests have not been made. Black Voronezh (C. I. No. 16) or selections from it has been grown

FIG. 11.—Plat of Black Voronezh proso at the Akron Field Station, with the station buildings in the background, in 1915. (From a photograph lent by the Office of Exhibits, U. S. Department of Agriculture.)

during five years. A plat of this variety in 1915 is shown in figure 11. It was first sown in field plats in 1909, when it produced a yield of 22.9 bushels per acre. It was again sown in field plats in 1912 and each of the three years following. The highest yield recorded was 36 bushels in 1912. The 5-year average is 23.1 bushels. Except possibly as a catch crop, proso can not be recommended for this district.

GRAIN SORGHUMS.

Grain sorghums have been grown in field plats for five years. On account of the short growing season and cool nights, most varieties fail to mature. Manchu Brown kaoliang (C. I. No. 328) is the only variety of apparent value in the Akron district. The highest yield

was 18.7 bushels, produced in 1913. The lowest yield, 11.7 bushels, was produced in 1915. The average yield in the five years, 1911 to 1915, inclusive, was 15.4 bushels. Because of the fact that some of the sorgos, or saccharine sorghums, produce as much grain and in addition yield more forage, grain sorghums can not be recommended to farmers of this district at the present time. Farther south and east, milo and dwarf milo are well adapted.

SUMMARY.

Cooperative experiments with cereals have been conducted at the Akron Field Station during the eight years, 1908 to 1915, inclusive.

The station is located in the north-central part of Washington County, in northeastern Colorado, at an altitude of approximately 4,560 feet.

The average annual precipitation in the 11 years, 1905 to 1915, inclusive, was 19.72 inches. The average seasonal rainfall (March to July, inclusive) was 12.33 inches. About two-thirds of the rainfall occurs during the growing season.

The average evaporation from a free water surface during the six months from April to September, inclusive, for the 8-year period, 1908 to 1915, inclusive, was 42.08 inches. The average precipitation in the same period was 14.11 inches.

The average hourly wind velocity during the months from April to September, inclusive, for the eight years was 7.1 miles.

The average length of the frost-free period for the eight years was 136 days. The average date of the last killing frost in spring was May 13, and of the first killing frost in autumn, September 26.

The soil of the Akron Field Station is a fine sandy loam.

The cereals tested on field plats have included 17 varieties and strains of winter wheat, 44 of spring wheat, 16 of oats, 19 of barley, and one or more of each of the minor cereals, rye, emmer, flax, proso, and grain sorghums.

Winter wheat has given better results than spring wheat. The durum wheats have produced higher average yields than spring common wheats.

Crimean winter wheat (C. I. No. 1436) produced the highest average yield of any winter wheat tested during the eight years, 1908 to 1915, inclusive, namely, 22 bushels. The Kharkof variety (C. I. No. 1583) ranks second, with 21.6 bushels.

Pelissier durum wheat (C. I. No. 1584) produced 22.4 bushels, the highest average yield of any spring wheat in the eight years, 1908 to 1915, inclusive. The Velvet Don (C. I. No. 1445) was second, with a yield of 21.5 bushels, and the Arnautka (C. I. No. 1493) third, with

21.1 bushels. Ghirka Spring wheat, of the Fife group, yielded 18.6 bushels.

Rate-of-seeding tests with winter wheat have not been satisfactory, but 3 pecks is thought to be the best rate.

Date-of-seeding tests with winter wheat indicate that the period between September 15 and October 15 is the best time to sow.

A rate-of-seeding test with spring wheat indicates that sowing 3 to 4 pecks will produce the best yields.

Considering yields per acre and market value, winter wheat is more profitable than spring wheat and spring durum more profitable than spring common wheat.

The best varieties of oats tested in the eight years, 1908 to 1915, are Kherson, with an average yield of 44.7 bushels, and Colorado No. 37, yielding 43.9 bushels. The Kherson is an early variety and Colorado No. 37 a midseason variety. Late varieties have yielded much less than the early or midseason varieties.

Rate-of-seeding tests with the Kherson oats indicate that the best yields are obtained by sowing 4 pecks per acre.

The best varieties of barley tested in the eight years are the Hannchen (C. I. No. 602), with an average yield of 38.7 bushels, and the Coast (C. I. No. 690), with a yield of 38.0 bushels. The 2-rowed group of barleys has averaged better than the 6-rowed group.

Winter rye has proven inferior in value to wheat.

Winter emmer has not been able to withstand winterkilling sufficiently. The 8-year average yield is 14.2 bushels.

White Spring emmer has averaged 30.3 bushels per acre and is therefore inferior to wheat or barley.

Flax has not produced well on account of its inability to successfully compete with weeds.

Proso, grown in field plats for five years, has averaged 23.1 bushels. Its main value seems to be as a catch crop.

No grain sorghum has made good yields. Most varieties fail to mature. The 5-year average yield of Manchu Brown kaoliang is 15.4 bushels per acre.

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